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Task II - Item 1 Submicron Measurement Error Analysis

Comments on some Vibration Measurements

WORK STATEMENT

Evaluate the physical and metallurgical properties of materials used in measuring engine construction to determine comparative suitability to submicron measuring. Materials to be considered are: Meehanite, steel, granite, aluminum, magnesium, and glass, and other materials that may be particularly suitable.

Evaluate physical properties and structural concepts appropriate to achievement of vibration levels and structural rigidity compatible with submicron measuring requirements. Evaluate methods of measuring the small vibration levels expected in a high performance structure.

Reports No. 1 and No. 2 dealt with the physical and metallurgical properties of materials. Report No. 3 dealt with structural rigidity and vibration control of the machine structure. Report No. 4 presented results of a computer analysis of building floor vibration frequency. This technical note contains comments on building floor vibration measurements.

Submitted by:

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Technical Note on Building Floor Vibration Measurements

In technical report no. 4, dated July 30, 1965, the results were presented of a computer analysis of the free-vibration mode of a typical bay in the building in which the submicron measuring instrument will be used. The computer analysis indicated that the fundamental mode of the floor slab vibration was 15.6 cps. This is considerably lower than the 20 cps to 65 cps previously estimated from manual calculations. The lower floor slab frequency makes it much more difficult to achieve effective vibration isolation between the floor slab and the measuring instrument. Whereas we had previously believed that an 8 cps mount would be satisfactory (for floor frequencies of 30 cps and higher), it now appears that a 2 cps mount is necessary for 15 cps input from the floor. Fig. 1 illustrates the greater effectiveness of a 2 cps mount.

An attempt was made to detect floor slab resonant frequencies but results were questionable. During the day we were not able to excite the floor slab above the background level. A test was made in the early morning when the background level was low and 30 cps, 60 cps and 90 cps was detected. The results are suspect because we could not be assured that we were not measuring stray voltages from the 60 cps building power.

A report on Bureau of Standards floor vibration measurements made in 1960 was reviewed. The report indicated that on the second floor, the vertical component could go as low as 5 to 7 cps and horizontal components as low as 3 to 5 cps. Effective isolation of frequencies that low is hopeless. In fact we hesitate to recommend a mount as soft as 2 cps. A mount suspended on vibration isolators that soft is awkward for an operator to work on because small forces create large excursions. For an 8 cps mount the 1g excursion is only 0.165

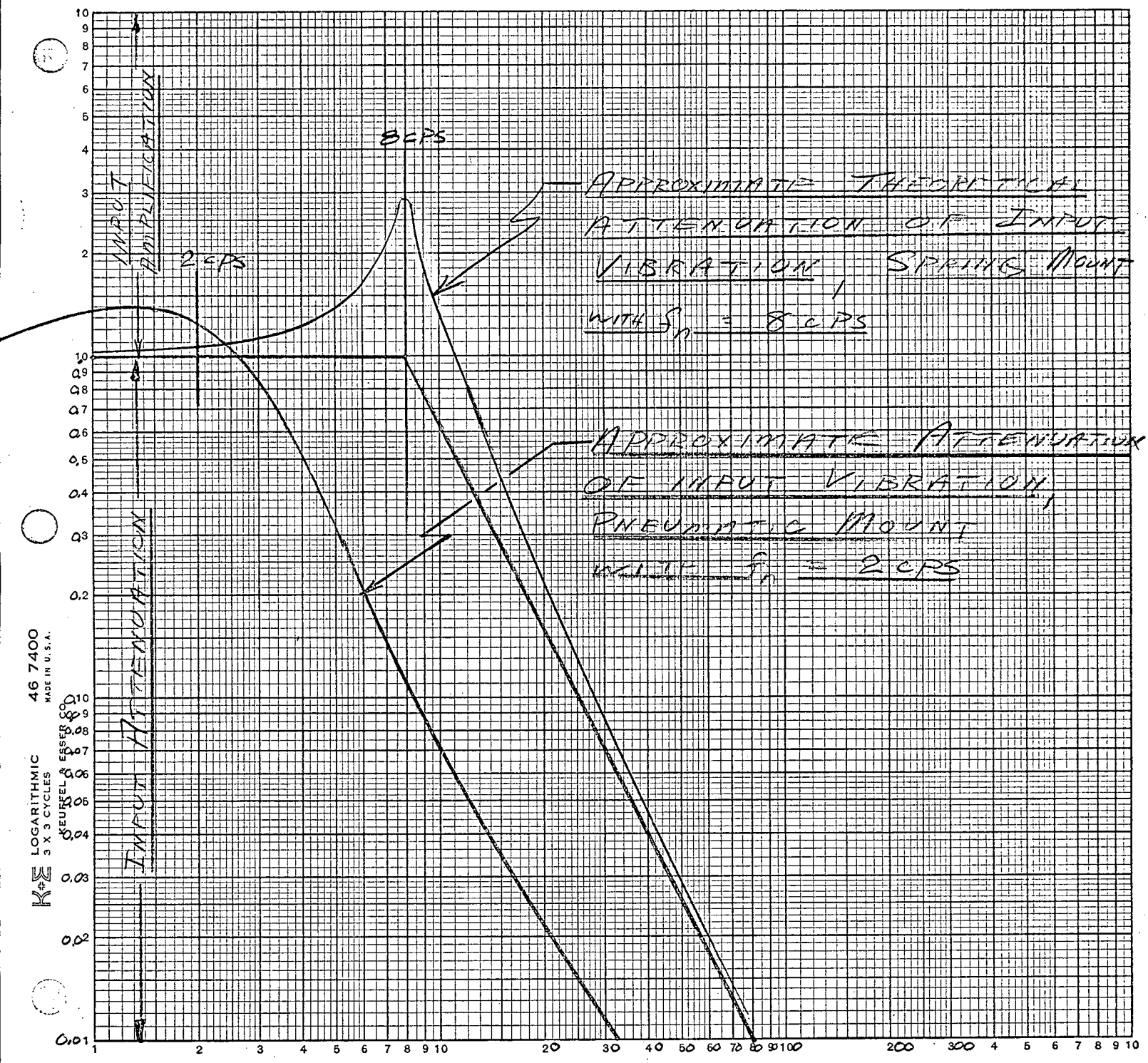

FIG 1.

inches but for a 2 cps mount the 1g excursion is 2½ inches.

Present thinking is that it may be better to use 8 cps pneumatic vibration isolators and design the instrument structure so that it will move as a single mass at 25 cps and below. Pneumatic is emphasized in the above statement because it is one of the few types of support which do not provide a high frequency path (90 cps to 500 cps and up).